Apprenticeship and Industry Training

Refrigeration and Air Conditioning Mechanic Apprenticeship Course Outline

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Apprenticeship and Industry Training

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Refrigeration and Air Conditioning Mechanic

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Course Outline

Apprenticeship

Apprenticeship is post-secondary education with a difference. Apprenticeship begins with finding an employer. Employers hire apprentices, pay their wages and provide on-the-job training and work experience. Approximately 80 per cent of an apprentice's time is spent on the job under the supervision of a certified journeyperson or qualified tradesperson. The other 20 per cent involves technical training provided at, or through, a post-secondary institution – usually a college or technical institute.

To become certified journeypersons, apprentices must learn theory and skills, and they must pass examinations. Requirements for certification—including the content and delivery of technical training—are developed and updated by the Alberta Apprenticeship and Industry Training Board on the recommendation of Refrigeration and Air Conditioning Mechanic Technician Provincial Apprenticeship Committee.

The graduate of the Refrigeration and Air Conditioning Mechanic apprenticeship training is a journeyman who will:

- supervise, train and coach apprentices
- use and maintain hand and power tools to the standards of competency and safety required in the trade
- have a thorough knowledge of the principle components of refrigeration systems, heat/cool units and air conditioning
- have a thorough knowledge of the electrical and automatic controls used in all aspects of the refrigeration and air conditioning industry
- be capable of assembling, installing or over hauling all components
- have an intimate knowledge of other mechanical trades, which contribute to refrigeration and air conditioning systems
- be proficient in the use of test instruments
- exercise good judgment and resourcefulness in construction, maintenance and workplace health and safety
- know, and be able to apply their knowledge of the installation, and service of HVAC systems in accordance with local, provincial and national standards for the industry
- do all Refrigeration and Air Conditioning Mechanic tasks expected of a journeyman.

Apprenticeship and Industry Training System

Industry-Driven

Alberta's apprenticeship and industry training system is an industry-driven system that ensures a highly skilled, internationally competitive workforce in more than 50 designated trades and occupations. This workforce supports the economic progress of Alberta and its competitive role in the global market. Industry (employers and employees) establishes training and certification standards and provides direction to the system through an industry committee network and the Alberta Apprenticeship and Industry Training Board. The Alberta government provides the legislative framework and administrative support for the apprenticeship and industry training system.

Alberta Apprenticeship and Industry Training Board

The Alberta Apprenticeship and Industry Training Board provides a leadership role in developing Alberta's highly skilled and trained workforce. The board's primary responsibility is to establish the standards and requirements for training and certification in programs under the Apprenticeship and Industry Training Act. The board also provides advice to the Minister of Advanced Education and Technology on the needs of Alberta's labour market for skilled and trained workers, and the designation of trades and occupations.

The thirteen-member board consists of a chair, eight members representing trades and four members representing other industries. There are equal numbers of employer and employee representatives.

Industry Committee Network

Alberta's apprenticeship and industry training system relies on a network of industry committees, including local and provincial apprenticeship committees in the designated trades, and occupational committees in the designated occupations. The network also includes other committees such as provisional committees that are established before the designation of a new trade or occupation comes into effect. All trade committees are composed of equal numbers of employer and employee representatives. The industry committee network is the foundation of Alberta's apprenticeship and industry training system.

Local Apprenticeship Committees (LAC)

Wherever there is activity in a trade, the board can set up a local apprenticeship committee. The board appoints equal numbers of employee and employer representatives for terms of up to three years. The committee appoints a member as presiding officer. Local apprenticeship committees:

- monitor apprenticeship programs and the progress of apprentices in their trade, at the local level
- make recommendations to their trade's provincial apprenticeship committee (PAC) about apprenticeship and certification in their trade
- promote apprenticeship programs and training and the pursuit of careers in their trade
- make recommendations to the board about the appointment of members to their trade's PAC
- help settle certain kinds of disagreements between apprentices and their employers
- carry out functions assigned by their trade's PAC or the board

Provincial Apprenticeship Committees (PAC)

The board establishes a provincial apprenticeship committee for each trade. It appoints an equal number of employer and employee representatives, and, on the PAC's recommendation, a presiding officer - each for a maximum of two terms of up to three years. Most PACs have nine members but can have as many as twenty-one. Provincial apprenticeship committees:

- Make recommendations to the board about:
    - standards and requirements for training and certification in their trade
    - courses and examinations in their trade
    - apprenticeship and certification
    - designation of trades and occupations
    - regulations and orders under the Apprenticeship and Industry Training Act
- monitor the activities of local apprenticeship committees in their trade
- determine whether training of various kinds is equivalent to training provided in an apprenticeship program in their trade
- promote apprenticeship programs and training and the pursuit of careers in their trade
- consult with other committees under the Apprenticeship and Industry Training Act about apprenticeship programs, training and certification and facilitate cooperation between different trades and occupations
- consult with organizations, associations and people who have an interest in their trade and with employers and employees in their trade
- may participate in resolving certain disagreements between employers and employees
- carry out functions assigned by the board
- .

Refrigeration and Air Conditioning Mechanic PAC Members at the Time of Publication

Mr. Art McMullen	Red Deer	Presiding Officer
Mr. Wayne Brilz	Calgary	Employer
Mr. Lyn Doudiet	Edmonton	Employer
Mr. Rod Dufresne	Okotoks	Employer
Mr. Michael Harper	Sherwood Park	Employee
Mr. Shannon Malone	Edmonton	Employee
Mr. Craig Mathes	Calgary	Employee
Mr. Geoff Mitchell	Edmonton	Employee

Alberta Government

Alberta Advanced Education and Technology works with industry, employer and employee organizations and technical training providers to:

- facilitate industry's development and maintenance of training and certification standards
- provide registration and counselling services to apprentices and employers
- coordinate technical training in collaboration with training providers
- certify apprentices and others who meet industry standards

Technical Institutes and Colleges

The technical institutes and colleges are key participants in Alberta's apprenticeship and industry training system. They work with the board, industry committees and Alberta Advanced Education and Technology to enhance access and responsiveness to industry needs through the delivery of the technical training component of apprenticeship programs. They develop lesson plans from the course outlines established by industry and provide technical training to apprentices.

Apprenticeship Safety

Safe working procedures and conditions, incident/injury prevention, and the preservation of health are of primary importance in apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of government, employers, employees, apprentices and the public. Therefore, it is imperative that all parties are aware of circumstances that may lead to injury or harm.

Safe learning experiences and healthy environments can be created by controlling the variables and behaviours that may contribute to or cause an incident or injury. By practicing a safe and healthy attitude, everyone can enjoy the benefit of an incident and injury free environment.

Alberta Apprenticeship and Industry Training Board Safety Policy

The Alberta Apprenticeship and Industry Training Board (board) fully supports safe learning and working environments and emphasizes the importance of safety awareness and education throughout apprenticeship training- in both on-the- job training and technical training. The board also recognizes that safety awareness and education begins on the first day of on-the-job training and thereby is the initial and ongoing responsibility of the employer and the apprentice as required under workplace health and safety training. However the board encourages that safe workplace behaviour is modeled not only during on-the-job training but also during all aspects of technical training, in particular, shop or lab instruction. Therefore the board recognizes that safety awareness and training in apprenticeship technical training reinforces, but does not replace, employer safety training that is required under workplace health and safety legislation.

The board has established a policy with respect to safety awareness and training:

> **The board promotes and supports safe workplaces, which embody a culture of safety for all apprentices, employers and employees. Employer required safety training is the responsibility of the employer and the apprentice, as required under legislation other than the *Apprenticeship and Industry Training Act.***

The board's complete document on its 'Apprenticeship Safety Training Policy' is available at www.tradesecrets.gov.ab.ca; access the website and conduct a search for 'safety training policy'.

Implementation of the policy includes three common safety learning outcomes and objectives for all trade course outlines. These common learning outcomes ensure that each course outline utilizes common language consistent with workplace health and safety terminology. Under the title of 'Standard Workplace Safety', this first section of each trade course outline enables the delivery of generic safety training; technical training providers will provide trade specific examples related to the content delivery of course outline safety training.

Addendum
As immediate implementation of the board's safety policy includes common safety learning outcomes and objectives for all course outlines, this trade's PAC will be inserting these safety outcomes into the main body of their course outline at a later date. In the meantime the addendum below immediately places the safety outcomes and their objectives into this course outline thereby enabling technical training providers to deliver the content of these safety outcomes.

STANDARD WORKPLACE SAFETY

A. Safety Legislation, Regulations & Industry Policy in the Trades .....

Outcome: ***Describe legislation, regulations and practices intended to ensure a safe work place in this trade.***

1. Demonstrate the ability to apply the Occupational Health and Safety Act, Regulation and Code.
2. Explain the role of the employer and employee in regard to Occupational Health and Safety (OH&S) regulations, Worksite Hazardous Materials Information Systems (WHMIS), fire regulations, Workers Compensation Board regulations, and related advisory bodies and agencies.
3. Explain industry practices for hazard assessment and control procedures.
4. Describe the responsibilities of workers and employers to apply emergency procedures.
5. Describe positive tradesperson attitudes with respect to housekeeping, personal protective equipment and emergency procedures.
6. Describe the roles and responsibilities of employers and employees with respect to the selection and use of personal protective equipment (PPE).
7. Select, use and maintain appropriate PPE for worksite applications.

B. Climbing, Lifting, Rigging and Hoisting .....

Outcome: ***Describe the use of personal protective equipment (PPE) and safe practices for climbing, lifting, rigging and hoisting in this trade.***

1. Select, use and maintain specialized PPE for climbing, lifting and load moving equipment.
2. Describe manual lifting procedures using correct body mechanics.
3. Describe rigging hardware and the safety factor associated with each item.
4. Select the correct equipment for rigging typical loads.
5. Describe hoisting and load moving procedures.

C. Hazardous Materials & Fire Protection.....

Outcome: ***Describe the safety practices for hazardous materials and fire protection in this trade.***

1. Describe the roles, responsibilities features and practices related to the workplace hazardous materials information system (WHMIS) program.
2. Describe the three key elements of WHMIS.
3. Describe handling, storing and transporting procedures when dealing with hazardous material.
4. Describe safe venting procedures when working with hazardous materials.
5. Describe fire hazards, classes, procedures and equipment related to fire protection.

Workplace Health and Safety

A tradesperson is often exposed to more hazards than any other person in the work force and therefore should be familiar with and apply the Occupational Health and Safety Act, Regulations and Code when dealing with personal safety and the special safety rules that apply to all daily tasks.

Workplace Health and Safety (Alberta Employment, Immigration and Industry) conducts periodic inspections of workplaces to ensure that safety regulations for industry are being observed.

Additional information is available at www.worksafely.org

Technical Training

Apprenticeship technical training is delivered by the technical institutes and many colleges in the public post-secondary system throughout Alberta. The colleges and institutes are committed to delivering the technical training component of Alberta apprenticeship programs in a safe, efficient and effective manner. All training providers place great emphasis on safe technical practices that complement safe workplace practices and help to develop a skilled, safe workforce.

The following institutions deliver Refrigeration and Air Conditioning Mechanic apprenticeship technical training:

Northern Alberta Institute of Technology
Southern Alberta Institute of Technology

Procedures for Recommending Revisions to the Course Outline

Advanced Education and Technology has prepared this course outline in partnership with the Refrigeration and Air Conditioning Mechanic Provincial Apprenticeship Committee.

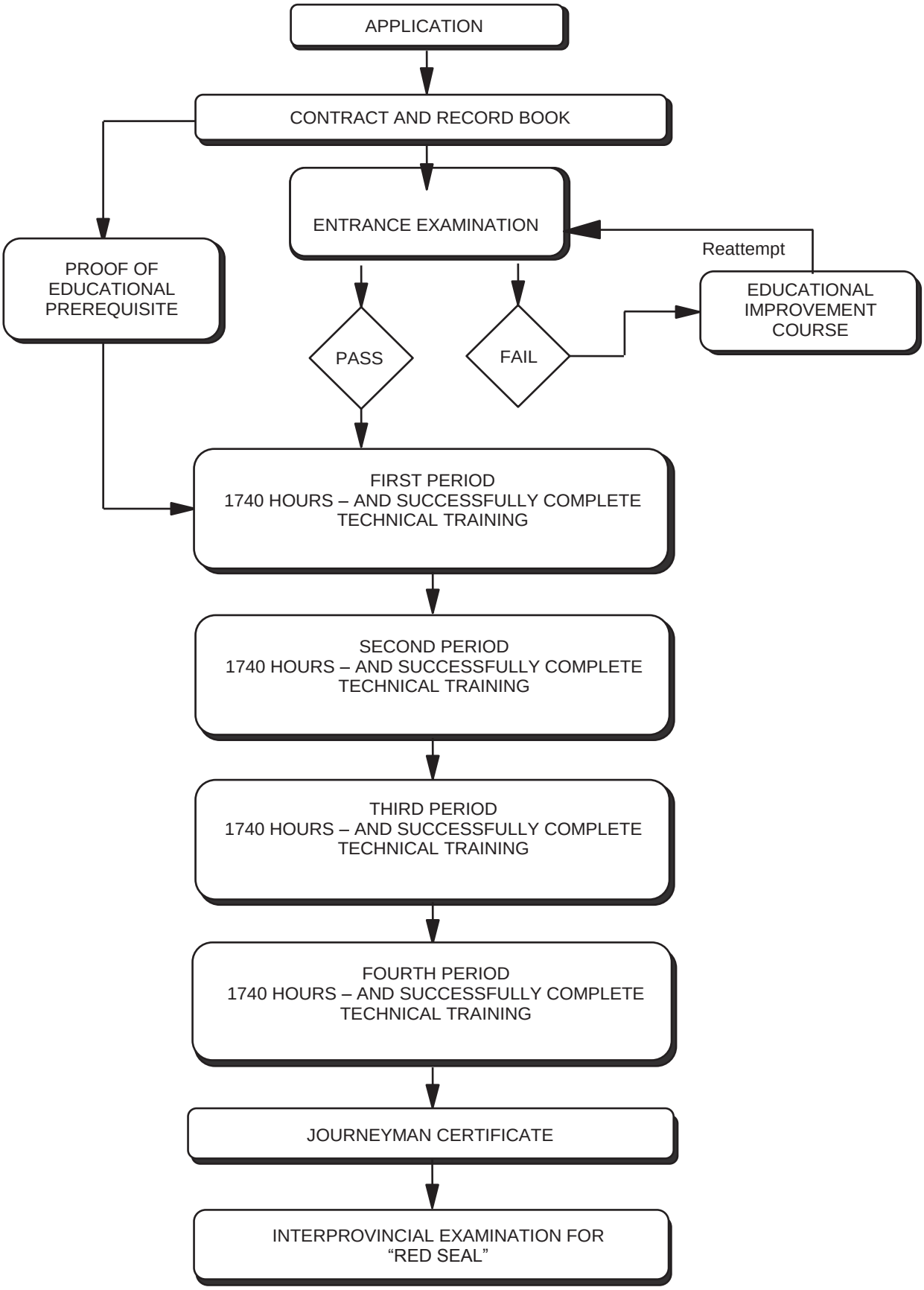
This course outline was approved on December 9, 2010 by the Alberta Apprenticeship and Industry Training Board on a recommendation from the Provincial Apprenticeship Committee. The valuable input provided by representatives of industry and the institutions that provide the technical training is acknowledged.

Any concerned individual or group in the province of Alberta may make recommendations for change by writing to:

Refrigeration and Air Conditioning Mechanic Provincial Apprenticeship Committee
c/o Industry Programs and Standards
Apprenticeship and Industry Training
Advanced Education and Technology
10th floor, Commerce Place
10155 102 Street NW
Edmonton AB T5J 4L5

It is requested that recommendations for change refer to specific areas and state references used. Recommendations for change will be placed on the agenda for regular meetings of the Refrigeration and Air Conditioning Mechanic Provincial Apprenticeship Committee.

Apprenticeship Route Toward Certification



Refrigeration and Air Conditioning Mechanic Training Profile
FIRST PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)

SECTION ONE

OCCUPATIONAL SKILLS
56 HOURS

A	B	C
Refrigeration and Air Conditioning Mechanic Apprenticeship Program 2 Hours	Workplace Safety 4 Hours	Tools and Instruments 10 Hours
D	**E**	**F**
Ladders, Scaffolds and Lifts 2 Hours	Introduction to Rigging 4 Hours	Rigging and Hoisting Equipment 4 Hours
G	**H**	**I**
Relevant Codes 2 Hours	Customer Relations 4 Hours	Introduction to Blueprint Reading 4 Hours
J		
Pipe Working Skills Soldering and Brazing 20 Hours		

SECTION TWO

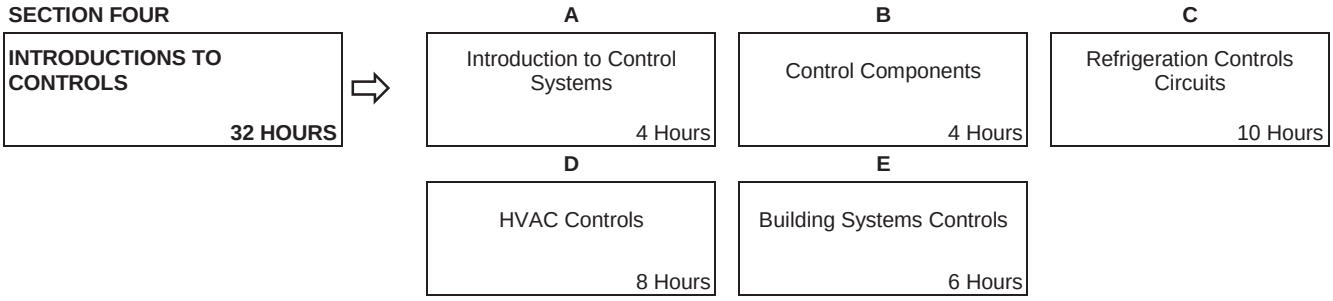
INTRODUCTION TO REFRIGERATION and AIR CONDITIONING AND HEATING
104 HOURS

A	B	C
Refrigeration Principles 14 Hours	Vapour Compression Cycle 10 Hours	Introduction to Refrigeration Enthalpy and Gas Laws 20 Hours
D	**E**	**F**
Air Properties and Air Flow Designs 10 Hours	Air Handling Systems and Accessories 10 Hours	Air Filtration 4 Hours
G	**H**	**I**
Refrigeration and Air Conditioning Relevant Codes 4 Hours	Introduction to Valve Design and Functions 4 Hours	Refrigerant and Oil Handling 14 Hours
J	**K**	**L**
Introduction Gasfitting Fundamentals 5 Hours	Properties of Gas and Principles of Combustion 4 Hours	Introduction Gasfitting Code and Regulations 5 Hours

SECTION THREE

INTRODUCTION TO ELECTRICAL THEORY
48 HOURS

A	B	C
Introduction to Electrical Safety and Meters 4 Hours	Current, Voltage, and Resistance 8 Hours	Series Resistive Circuits 6 Hours
D	**E**	**F**
Parallel Resistive Circuits 4 Hours	Series-Parallel Resistive Circuits 12 Hours	Methods of Producing EMF and Magnetism 8 Hours
G		
Fundamentals of Alternating Current 6 Hours		


SECTION FOUR
INTRODUCTIONS TO CONTROLS
32 HOURS
A
Introduction to Control Systems
4 Hours
B
Control Components
4 Hours
C
Refrigeration Controls Circuits
10 Hours
D
HVAC Controls
8 Hours
E
Building Systems Controls
6 Hours

SECOND PERIOD

(8 Weeks/30 Hours per Week – Total of 240 Hours)

SECTION ONE

BASIC REFRIGERATION AND AIR CONDITIONING
128 HOURS

A	B	C
Evaporator Feed Controls and Refrigeration Effect – 16 Hours	Automatic Flow Controls and Applications – 10 Hours	Refrigeration Accessories – 4 Hours
D	**E**	**F**
Compressors – 14 Hours	Evaporators and Condensers – 6 Hours	Evaporating Condensers and Cooling Towers – 6 Hours
G	**H**	**I**
System Install and Commissioning – 36 Hours	System Calculations and Analysis – 24 Hours	Retrofitting and Conversions – 8 Hours
J		
Split Systems – 4 Hours		

SECTION TWO

BASIC HEATING
32 HOURS

A	B	C
Natural Draft Burner Adjustments and Gas Adjustments – 6 Hours	Pilots, Pilot Burners, Thermocouples and Thermopiles – 6 Hours	Pressure Regulators and Orifices – 8 Hours
D	**E**	**F**
Introduction to Flues, Draft Hoods and Vent Connections – 6 Hours	Single Line Drawings – 4 Hours	Heating with Alternative Methods – 2 Hours

SECTION THREE

BASIC CONTROLS
32 HOURS

A	B	C
Principles of Automatic Heating and Cooling Controls – 6 Hours	Temperature Sensing and Control Devices – 4 Hours	Basic Gas-Fired Forced-Air Heating Systems – 6 Hours
D	**E**	**F**
Mid/High-Efficiency / Gas-Fired / Forced-Air Heating Systems – 6 Hours	Basic Hot Water Heating Systems – 2 Hours	HVAC Rooftop Units – 8 Hours

SECTION FOUR

BASIC ELECTRICAL THEORY
48 HOURS

A	B	C
Transformers – 4 Hours	Single Phase Motors – 14 Hours	Compressor and Electrical Circuit Components – 10 Hours
D	**E**	**F**
Three Phase Fundamentals – 6 Hours	Troubleshooting Electrical Problems – 8 Hours	Introduction to Canadian Electrical Code – 4 Hours
G		
Class 1 and Class 2 Circuits – 2 Hours		

THIRD PERIOD
(8 Weeks/30 Hours per Week – Total of 240 Hours)

SECTION ONE

INTERMEDIATE REFRIGERATION AND AIR CONDITIONING
112 HOURS

A	B	C
Refrigeration Load Calculations and Design 10 Hours	System Design and Equipment Selection 14 Hours	Piping Design and Installation Practices 36 Hours
D	**E**	**F**
Defrosting Methods Circuits and Controls 10 Hours	Troubleshooting of Refrigeration and HVAC Systems 30 Hours	Industrial Refrigeration Systems 8 Hours
G		
Codes Related to Refrigeration and Air Conditioning Installations 4 Hours		

SECTION TWO

INTERMEDIATE HEATING THEORY
32 HOURS

A	B	C
Electronic Ignition Systems 12 Hours	Natural and Fan Assisted Draft Appliances 12 Hours	Introduction to Make Up Air 8 Hours

SECTION THREE

ELECTRICAL AND PNUEMATIC THEORY
40 HOURS

A	B	C
Introduction to Three Phase Motors 3 Hours	Operation of Three Phase Motors 3 Hours	Motor Installations 14 Hours
D	**E**	**F**
Variable Speed Drives 8 Hours	Arc Flash 2 Hours	Diagrams 6 Hours
G		
Pneumatic Control Systems 4 Hours		

SECTION FOUR

AIR HANDLING THEORY
56 HOURS

A	B	C
HVAC Load Calculations and Design 8 Hours	Advanced Air Properties 6 Hours	Air Conditioning Systems 32 Hours
D	**E**	
Fan Belts and Mechanical Drive Systems 4 Hours	Air Instruments and System Balancing 6 Hours	

FOURTH PERIOD
(8 Weeks/30 Hours per Week – Total of 240 Hours)

SECTION ONE

ADVANCED REFRIGERATION THEORY
80 HOURS

A	B	C
Chillers 14 Hours	Ultra Low Compression Systems 10 Hours	Multiplex Systems 16 Hours
D	**E**	**F**
Industrial Refrigeration Systems 20 Hours	Circulating Pumps 8 Hours	B52 Piping Codes and Canadian Code of Practice 4 Hours
G		
Advanced Blueprint Reading 8 Hours		

SECTION TWO

ADVANCED HEATING THEORY
48 HOURS

A	B	C
Troubleshooting Gas Fired Equipment 8 Hours	Combustion Analysis 8 Hours	Advanced Make-up Air Systems 16 Hours
D	**E**	**F**
Troubleshooting Make-up Air Systems 8 Hours	Hot Tapping 4 Hours	Workplace Coaching Skills/Mentoring 4 Hours

SECTION THREE

COMPLEX AIR SYSTEM THEORY
40 HOURS

A	B	C
Complex HVAC Systems 10 Hours	Troubleshooting Complex HVAC Systems 12 Hours	Advanced Mechanical Drives for Fan Systems 4 Hours
D	**E**	**F**
Installation of HVAC Equipment 8 Hours	Energy Conservation and Indoor Air Quality 4 Hours	Advisory Network 2 Hours

SECTION FOUR

ADVANCED CONTROL SYSTEMS
72 HOURS

A	B	C
Specialized Electronic Control Systems 16 Hours	Electromechanical Control Systems 12 Hours	Advanced Electrical Troubleshooting 8 Hours
D	**E**	**F**
Schematic Drawings 10 Hours	Economizer Controls and Accessories 14 Hours	New Environmental Technology 8 Hours
G	**H**	
Back-Flow Prevention (Cross-Connection Control Awareness) 2 Hours	Interprovincial Standards 2 Hours	

NOTE: The hours stated are for guidance and should be adhered to as closely as possible. However, adjustments must be made for rate of apprentice learning, statutory holidays, registration and examinations for the training establishment and Apprenticeship and Industry Training

FIRST PERIOD TECHNICAL TRAINING
REFRIGERATION AND AIR CONDITIONING MECHANIC TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS COURSE THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE: ..... OCCUPATIONAL SKILLS ..... 56 HOURS

A. Refrigeration Air Condition Mechanic Apprenticeship Training Program Orientation ..... 2 Hours

Outcome: Understand the role of the trades people, employers, Local Apprenticeship Committees, the Provincial Apprenticeship Committee and Alberta Apprenticeship and Industry Training in the development and maintenance of the Refrigeration and Air Conditioning Mechanic trade in Alberta.

1. Describe the apprenticeship training system in Alberta.
2. Describe the training profile of the Refrigeration and Air Conditioning Mechanic apprenticeship in Alberta.
3. Describe the Refrigeration and Air Conditioning Mechanic program outline learning outcomes and objectives.
4. Describe the responsibilities for the Contract of Apprenticeship by the apprentice employer and Alberta Apprenticeship and Industry Training.
5. Describe a variety of employment opportunities for Refrigeration and Air Conditioning Mechanic.
6. Become familiar with the contents of the apprenticeship training record book.

B. Workplace Safety ..... 4 Hours

Outcome: Apply Occupational Health and Safety regulations and safe work practices.

1. Interpret Occupational Health and Safety regulations.
2. Describe requirements related to personal protective equipment and safety measures.
3. Describe emergency procedures when dealing with injured employees.
4. Describe potential health hazards.
5. Describe work alone policies.
6. Describe various fire extinguishers and their related use.

C. Tools and Instruments ..... 10 Hours

Outcome: Use hand tools, meters and power tools.

1. Describe the use of hand tools used in the refrigeration industry.
2. Describe the use of power tools used in the refrigeration industry.
3. Describe the use of meters used in the refrigeration industry.
4. Demonstrate the use of hand tools, power tools and meters used in the refrigeration industry.
5. Demonstrate proper connections of refrigeration gauges and operation of service valves.

D. Ladders, Scaffolds and Lifts ..... 2 Hours

Outcome: Use ladders, scaffolds and man lifts.

1. Describe the use of various types of ladders.
2. Describe the use of various types of scaffolds.
3. Describe the use of various types of lifts.
4. Describe the use of ladders, scaffolds and lifts.

E. Introduction to Rigging ..... 4 Hours

Outcome: Identify types of rope and various rigging components and tie basic knots and hitches.

1. Describe the various types, parts, care and maintenance of natural and synthetic rope.
2. Identify, describe and demonstrate the proper procedure for typing popular knots, and hitches including, square knot, round turn and half itch, clove hitch, timber hitch, bowline and sheet bend.
3. Describe the various types, parts and care and maintenance of wire ropes.
4. Recognize and name differences between chain falls, come-a-longs, tirfors and snatch blocks.

F. Rigging and Hoisting Equipment ..... 4 Hours

Outcome: Apply Occupational Health and Safety Regulations as it pertains to safe rigging and hoisting practices.

1. Describe characteristics of safe workloads detrimental application of different slings used for hoisting pipe, appliances and components.
2. Describe applications and positioning of cranes, hoists and cherry pickers.
3. Describe correct hand signals to be used when directing a crane.

G. Relevant Codes ..... 2 Hours

Outcome: Describe the relevant codes used in the refrigeration and air condition (RAC) industry.

1. Describe the refrigeration codes that apply to RAC work.
2. Describe the gas codes that apply to RAC work.
3. Describe the plumbing codes that apply to RAC work.
4. Describe the electrical codes that apply to RAC work.
5. Describe the sheet metal codes that apply to RAC work.

H. Customer Relations ..... 4 Hours

Outcome: Demonstrate effective customer relations.

1. Describe effective communication techniques.
2. Describe methods used to determine customers' needs.
3. Describe customer reporting methods.
4. Describe job completion strategies.

I. Introduction to Blueprint Reading ..... 4 Hours

Outcome: Interpret basic blueprint information.

1. Use basic information found on a blueprint.
2. Interpret basic blueprints.
3. Identify common symbols used in blueprints and legends.
4. Identify abbreviations commonly used in blueprints.

J. Pipe Working Skills, Soldering and Brazing ..... 20 Hours

Outcome: Apply pipe working skills on refrigeration, gas and plumbing pipe.

1. Describe tools, equipment and material used for pipe work.
2. Describe tools and equipment used for soldering.
3. Describe tools and equipment used for brazing.
4. Demonstrate use of tools, equipment and material for pipe work.
5. Demonstrate use of tools and equipment for soldering.
6. Demonstrate use of tools and equipment for brazing.

SECTION TWO: INTRODUCTION TO REFRIGERATION, AIR CONDITIONING AND HEATING..... 104 HOURS

A. Refrigeration Principles ..... 14 Hours

Outcome: Explain the basic operation of a refrigeration system.

1. Define the terms related to refrigeration principles.
2. Describe the basic concepts of heat transfer.
3. Describe different methods of heat transfer.
4. Describe the laws of thermal dynamics.
5. Describe the units of measure pertaining to heat transfer.
6. Perform calculations related to heat transfer.
7. Convert temperatures and pressures between various scales.

B. Vapour Compression Cycle ..... 10 Hours

Outcome: Explain the vapour compression cycle.

1. Describe the basic concepts of the vapour compression cycle.
2. Describe the four essential components of a refrigeration system.
3. Describe the stages of the refrigeration cycle.
4. Observe and measure the refrigeration cycle on a working system.

C. Introduction to Refrigeration Enthalpy and Gas Laws ..... 20 Hours

Outcome: Apply gas laws and pressure enthalpy charts to refrigeration systems.

1. Define terms used in refrigeration and heating.
2. Describe gas laws and how they apply to thermal dynamics.
3. Describe fluids and fluid piping systems as it relates to refrigeration systems.

4. Describe the units of measurement used in refrigeration calculations.
5. Describe formulas used in calculating gas laws and pressure enthalpy.
6. Describe the components of a pressure enthalpy diagram.
7. Plot a basic cycle using a pressure enthalpy diagram.
8. Demonstrate use of formulas for calculating gas laws and pressure enthalpy.

D. Air Properties and Air Flow Designs ..... 10 Hours

Outcome: Apply the properties of air as it relates to basic air flow design.

1. Describe air properties as it relates to heat transfer.
2. Describe methods of heat transfer as they relate to air flow.
3. Describe units of measurement as it relates to air properties.
4. Describe methods used in calculating air flow design.
5. Calculate air flow required for a given heat transfer system.

E. Air Handling Systems and Accessories ..... 10 Hours

Outcome: Explain air handling systems and accessories.

1. Describe air handling systems.
2. Describe air handling systems components.
3. Describe air handling accessories.
4. Describe air handling equipment maintenance requirements.
5. Define terms used in fans, belts and mechanical drives.
6. Demonstrate fan belt installation and mechanical drive alignment.

F. Air Filtration ..... 4 Hours

Outcome: Explain methods of air filtration.

1. Define terms related to filtration.
2. Define filtration components and their application.
3. Describe the operation and efficiency of air filters.
4. Calculate velocities and pressure drops through filters.

G. Refrigeration and Air Conditioning Relevant Codes ..... 4 Hours

Outcome: Apply how the B52 Mechanical Refrigeration Code and the Canadian Code of Practice are used to provide a minimum standard as it relates to Refrigeration and Air Conditioning Mechanic work in the province.

1. Explain the scope and jurisdiction of the different codes.
2. Describe how the B52 relates to the Refrigeration and Air Conditioning Mechanic trade.
3. Describe how the Canadian Code of Practice relates to the Refrigeration and Air Conditioning Mechanic trade.
4. Demonstrate how the B52 is used in determining minimum standards in a refrigeration and air conditioning install and maintenance work.

5. Demonstrate how the Canadian Code of Practice is used in determining minimum standards in a refrigeration and air conditioning install and maintenance work.

H. Introduction to Valve Design and Functions ..... 4 Hours

Outcome: Explain the application of valves as it applies to design and function.

1. Describe general vale designs.
2. Describe applications of various valves.
3. Describe valve designs for various refrigeration system applications.
4. Demonstrate operation of service valves.

I. Refrigerant and Oil Handling ..... 14 Hours

Outcome: Handle refrigerant and refrigeration oil safely.

1. Describe the evolution and properties of refrigerants and their oils.
2. Describe the safe handling and storage of refrigerants and refrigeration oils.
3. Describe the safe recovery and deposal of refrigerants and refrigeration oils.
4. Describe leak testing methods and instruments used.
5. Describe the evacuation process of refrigeration systems.
6. Demonstrate the safe recovery and deposal of refrigerants.
7. Demonstrate the safe recovery and deposal of refrigeration oils.
8. Demonstrate leak testing methods and instruments used.
9. Demonstrate the evacuation process of refrigeration systems.
10. Demonstrate the proper maintenance procedures of recovery and evacuation equipment.
11. Complete Heating Refrigeration Air Conditioning Institute (HRAI) refrigerant handling training.

J. Introduction Gasfitting Fundamentals ..... 5 Hours

Outcome: Explain and identify basic gas fundamentals and the purpose, legal status and organization of CAN/CSA Natural Gas and Propane Installation Codes B149.1, B149.2 and the Gas Bulletins.

1. Describe and interpret historical foundations, career opportunities and Trade Regulations.
2. Describe production, distribution and storage of natural gas.
3. Describe production, distribution and storage of propane gas.
4. State regulations pertaining to the general requirements of the gasfitter trade.
5. Identify regulations pertaining to the gasfitter trade.
6. Interpret regulations pertaining to the gasfitter trade.

K. Properties of Gas and Principles of Combustion ..... 4 Hours

Outcome: Explain basic gas fundamentals.

1. State chemical formulas as required for the Refrigeration and Air Conditioning Mechanic trade.
2. State the relative densities, liquefaction ratios and heating value of gases.
3. Calculate various trade related problems using properties of gases.

4. Identify definitions specific to combustion.
5. Explain the principles of combustion as a chemical change.
6. List and describe the products of complete and incomplete combustion and requirements for combustion air.
7. Describe flame adjustment techniques and correct safety practices when adjusting gas-fired equipment.

L. Introduction Gasfitting Code and Regulations.....5 Hours

Outcome: Identify and apply rules pertaining to the installation of piping and tubing systems for various conditions of use in accordance with the CAN/CSA B149.1 Natural Gas and Propane Installation Codes (Sections 1-4) and B149.2 Propane Storage and Handling and the Gas Safety Information Bulletins.

1. List and describe the regulations contained in the scope section of the CAN/CSA B149.1 Natural Gas and Propane Installation Codes, amendments to the code and the regulations pertaining to installers responsibilities.
2. State the regulations contained in the CAN/CSA B149.1 Natural Gas and Propane Installation Codes (Sections 1-4) and B149.2 Propane Storage and Handling and the Gas Safety Information Bulletins pertaining to installation of piping and fittings.
3. State the regulations contained in the CAN/CSA B149.1 Natural Gas and Propane Installation Codes (Sections 1-4) and B149.2 Propane Storage and Handling and the Gas Safety Information Bulletins pertaining to testing of piping and fittings.
4. State the regulations contained in the CAN/CSA B149.1 Natural Gas and Propane Installation Codes (Sections 1-4) and B149.2 Propane Storage and Handling and the Gas Safety Information Bulletins pertaining to purging of piping and fittings.
5. Describe correct safety practices to be used pertaining to installation of piping and fittings.
6. Describe correct safety practices to be used pertaining to testing of piping and fittings.
7. Describe correct safety practices to be used pertaining to purging of piping and fittings.

SECTION THREE: .....INTRODUCTION TO ELECTRICAL THEORY..... 48 HOURS

A. Introduction to Electrical Safety and Meters .....4 Hours

Outcome: Explain hazards related to working with electricity.

1. Describe the hazards related to working with electrical circuits.
2. Describe safety precautions when working with electrical circuits.
3. Describe lockout tag out procedures related to working on electrical equipment.
4. State the applications of the various meters.
5. List the precautions that must be observed when using meters.
6. Recognize the connections for various meters.
7. Demonstrate proper range selection and connections of voltmeter, ammeter, ohmmeter and megger.

B. Current, Voltage, and Resistance .....8 Hours

Outcome: Define voltage, current and resistance and predict how changing the value of any one of them affects the circuit.

1. Describe an electric current.

2. Describe voltage, current and power.
3. Describe resistance and state and apply Ohm's Law.
4. Connect and verify relationships between voltage, current and resistance according to Ohm's Law.

C. Series Resistive Circuits..... 6 Hours

Outcome: Connect and analyze a series resistive circuit and analyze the relationships between current, resistance and voltage.

1. Define a series circuit and calculate current in a series circuit.
2. State the formula for total resistance and calculate resistance in a series circuit.
3. State and apply Kirchhoff's voltage law to a series circuit.
4. Determine the voltage drop across a closed-or-open-circuit component in a series circuit.
5. Connect and verify Kirchhoff's current and voltage laws in a series resistive circuit.

D. Parallel Resistive Circuits.....4 Hours

Outcome: Connect and analyze the voltage, current and resistance characteristics of a parallel circuit.

1. Define a parallel circuit.
2. State and apply Kirchoff's current law to a parallel circuit.
3. Describe the effects of open circuits on a parallel circuit.
4. Connect and verify Kirchoff's current law in a parallel resistive circuit.

E. Series-Parallel Resistive Circuits .....12 Hours

Outcome: Connect and analyze a series-parallel resistive circuit.

1. Identify resistors that are in series.
2. Identify resistors that are in parallel.
3. Calculate the total resistance of a series-parallel circuit.
4. Apply Kirchhoff's current law.
5. Apply Kirchhoff's voltage law.
6. Solve problems involving series-parallel circuits.
7. Connect and verify the relationship of current, voltage and resistance in each part of a series/parallel circuit.

F. Methods of Producing EMF and Magnetism.....8 Hours

Outcome: Describe methods of producing EMF.

1. Explain the production of EMF by using chemicals.
2. Explain the production of EMF by using heat.
3. Explain the production of EMF by using pressure.
4. Explain the production of EMF by using light.
5. Explain the production of EMF by using magnetism.
6. Explain the production of EMF by using electrostatics.
7. Describe the properties of magnetic materials.

8. Define the terminology related to magnetism.
9. Describe electromagnetism and basic design considerations for electromagnetic devices.
10. Describe how an induced voltage is generated.
11. Describe the process of electromagnetic induction.

G. Fundamentals of Alternating Current ..... 6 Hours

Outcome: Describe the fundamental characteristics of ac circuits.

1. Explain the generation of an ac sine wave.
2. Determine the output frequency of an ac generator.
3. Calculate standard ac sine wave values.
4. Demonstrate the relationship between sine waves and phasor diagrams.
5. List the factors affecting impedance in an ac circuit.

SECTION FOUR: .....INTRODUCTION TO CONTROLS ..... 32 HOURS

A. Introduction to Control Systems .....4 Hours

Outcome: Explain various control systems used for heating and cooling.

1. Describe terminology used in control systems.
2. Describe heating and cooling controls.
3. Describe heating and cooling control systems.
4. Interpret electrical diagrams used to show the function of a heating or cooling control system.

B. Control Components.....4 Hours

Outcome: Explain components used in control systems.

1. Describe the components of heating and cooling systems.
2. Describe the construction of control system components.
3. Describe the application of control components for heating and cooling system.
4. Describe the operation of control system components.

C. Refrigeration Control Circuits.....10 Hours

Outcome: Explain control circuits for refrigeration systems.

1. Describe components used in control circuits for refrigeration systems.
2. Describe the differences between medium and low temperature control circuits.
3. Describe the components of a medium temperature control circuit.
4. Describe the components of a low temperature control circuit.
5. Connect a medium temperature cooling control system and observe operation.
6. Connect a low temperature cooling control system and observe operation.

D. HVAC Control Circuits ..... 8 Hours

Outcome: Explain HVAC control circuits.

1. Describe components used in HVAC control circuits.
2. Describe the construction of HVAC control system components.
3. Describe the application of control components for HVAC system.
4. Describe the operation of HVAC control system components.
5. Connect an HVAC control system and observe operation.

E. Building Systems Controls..... 6 Hours

Outcome: Explain building system control circuits.

1. Describe components used in building control circuits.
2. Describe the construction of building control system components.
3. Describe the application of control components for building system.
4. Describe the operation of building control systems.
5. Describe other systems that affect building control systems.

SECOND PERIOD TECHNICAL TRAINING
REFRIGERATION AND AIR CONDITIONING MECHANIC TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS COURSE THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE: ..... BASIC REFRIGERATION AND AIR CONDITIONING..... .128 HOURS

A. Evaporator Feed Controls and Refrigeration Effect .....16 Hours

Outcome: Explain the purpose of evaporator feed controls and refrigeration effect.

1. Define terms related to evaporator feed control and refrigeration effect.
2. Describe types and operations of evaporator feed controls.
3. Describe components of evaporator feed control systems.
4. Explain control characteristics of expansion control devices.
5. Describe methods of producing the refrigeration effect.
6. Determine the proper metering device for various applications.
7. Demonstrate troubleshooting techniques of metering devices.
8. Measure superheat and adjust a thermal expansion valve (TXV).

B. Automatic Flow Controls and Applications .....10 Hours

Outcome: Explain automatic flow control and their applications.

1. Define terms related automatic flow controls.
2. Describe components of automatic flow controls.
3. Describe the operation of automatic flow controls.
4. Describe the application of automatic flow controls.
5. Connect and service automatic flow controls.

C. Refrigeration Accessories .....4 Hours

Outcome: Explain refrigeration accessories

1. Define terms related to refrigeration accessories.
2. Describe components related to refrigeration accessories.
3. Describe the operation of various refrigeration accessories.
4. Describe the application of various refrigeration accessories.

D. Compressors .....14 Hours

Outcome: Explain the operation of compressors and components

1. Define terms related to compressors and refrigeration circuit components.
2. Describe types of compressors used in refrigeration and air conditioning systems.
3. Describe the components and operating characteristics of compressors.
4. Define terms related to compressor mechanical components.

5. Describe compressor components and their applications.
6. Describe the compression process and the flow of gas through the compressor.
7. Describe types of compressor lubrication.
8. Describe mechanical and electrical oil failure controls.
9. Describe capacity control systems.
10. Label a compressor circuit.
11. Disassemble and reassemble a small semi hermetic compressor.

E. Evaporators and Condensers ..... 6 Hours

Outcome: Explain the operation and components of evaporators and condensers.

1. Define terms related to evaporators and condensers.
2. Describe evaporator components and their applications.
3. Describe evaporator defrost methods.
4. Describe condenser components and their applications.
5. Describe service and repair of evaporator and condensers.
6. Demonstrate evaporator and condenser sizing and balancing methods.

F. Evaporators Condensers and Cooling Towers ..... 6 Hours

Outcome: Explain the operation and components of evaporative condensers and cooling towers.

1. Define terms related to evaporative condensers and cooling towers.
2. Describe evaporative condenser components and their applications.
3. Describe cooling tower components and their applications.
4. Describe water treatment procedures as it relates to cooling towers.
5. Describe seasonal operation of cooling towers.

G. System Install and Commissioning ..... 36 Hours

Outcome: Explain system install and commissioning of refrigeration and air conditioning (RAC) systems.

1. Describe methods of selecting and locating system components.
2. Describe the proper methods of mounting condensing units and evaporators.
3. Describe proper methods of connecting piping and accessories to an RAC system.
4. Compare the use of various piping materials.
5. Sketch and describe the electrical wiring schematic for a RAC system.
6. Sketch and describe the piping schematic for a RAC system.
7. Install and connect a RAC system.
8. Start-up and complete a commissioning report for an RAC system.

H. System Calculation and Analysis ..... 24 Hours

Outcome: Explain troubleshooting, system calculation and analysis of refrigeration and air conditioning (RAC) systems.

1. Define thermal dynamics as it pertains to service and troubleshooting of RAC systems.
2. Describe pressure enthalpy diagrams as they relate to various RAC system conditions.
3. Describe formulas used in analyzing system thermal dynamics.
4. Analyze and troubleshoot RAC systems using pressure enthalpy diagrams and system thermal dynamic formulas.
5. Select and use tools and charts to troubleshoot RAC systems under various conditions.

I. Retrofitting and Conversions ..... 8 Hours

Outcome: Explain methods used in retrofitting and conversions.

1. Describe steps used in designing and retrofitting or converting RAC systems.
2. Describe the hazards related to retrofitting or converting RAC systems.
3. Describe start-up and monitoring steps of a retrofitted or converted RAC system.

J. Split Systems ..... 4 Hours

Outcome: Explain the operation of and troubleshoot basic split cooling systems.

1. Identify the components used in a typical cooling system.
2. Describe the operation of a typical cooling system.
3. Identify the requirements for combining a basic cooling system with an existing forced-air heating system.
4. Connect and observe the operation of a combined heating and cooling system.

SECTION TWO: ..... BASIC HEATING ..... 32 HOURS

A. Natural Draft Burner Adjustments and Gas Consumptions ..... 6 Hours

Outcome: Install and adjust various pressure controls and gas-fired burners using ratings plates, gas meters, manometers and mechanical gauges to calculate consumption for gas-fired appliances.

1. Determine proper appliance settings using rating plates, altitude designation and listed approval agencies.
2. List and describe the requirements from the CAN/CSA B149.1 Natural Gas and Propane Installation Codes, CAN/CSA B149.2 Propane Storage and Handling Code and the Plumbing and Gas Safety Service Bulletin pertaining to gas appliance and adjustments and installers responsibilities.
3. List and define parts of a burner and common burner terminology.
4. Adjust and measure manifold pressures to determine gas consumption of burners in both imperial and metric units.
5. Identify and adjust various orifices and manifold pressures to determine gas consumption.
6. Identify and determine meter dials and meter indexes in both metric and imperial units.
7. Explain principles of low pressure gas meter clocking.
8. Calculate gas consumption using timed meter readings.

B. Pilots, Pilot Burners, Thermocouples and Thermopiles ..... 6 Hours

Outcome: Identify and service pilots, pilot burners, thermocouples and thermopiles.

1. List and describe common pilot burner types and terminology.
2. List and describe the characteristics of pilot burners and identify parts of aerated and non-aerated pilot burners.
3. State the primary purpose of a gas pilot and describe burner ignition tests performed on all pilots.
4. List and describe operating principles of thermocouples and thermopiles.
5. List and describe the operation tests performed on proven pilots energizing a thermocouple.
6. List and describe methods of installing thermocouples and thermopiles on standard circuits.
7. List and describe operational tests performed on thermocouples and thermopiles.
8. List and describe diagnostic tests for thermocouples and state major causes for thermocouple failures.

C. Pressure Regulators and Orifices ..... 8 Hours

Outcome: Install and service various types of gas pressure controls and burner orifices and adjust gas line pressure.

1. Describe types, operating principles and applications or various gas pressure regulators.
2. Identify various regulator sizing tables and list and describe correct installation procedures for various regulators.
3. List and describe maintenance procedures for various regulators.
4. List some common pressure regulator problems and describe and apply corrective procedures.
5. Identify various types of orifices.
6. Use orifice sizing charts to determine orifice sizing for specific gas consumptions and pressure in both metric and imperial units.
7. Select the correct type of orifice and demonstrate drilling an orifice to correct size using appropriate methods.
8. Demonstrate proper procedure for testing an orifice, adjust manifold pressure if necessary and clock meter to determine accuracy.

D. Introduction to Flues, Draft Hoods and Vent Connections ..... 6 Hours

Outcome: Install and service draft hoods and vent connectors.

1. Define terminology pertaining to flues and draft control devices.
2. Identify and describe flue collars and common types of draft hoods including correct installation procedures.
3. Explain regulations pertaining to the sizing, installation and use of draft hoods on gas burning appliances as listed in the CAN/CSA B149.1 *Natural Gas and Propane Installation Code and STANDATA*.
4. Describe correct installation procedures for single and double acting barometric dampers.
5. Explain regulations pertaining to the selection, sizing, installation and use of draft control devices as specified in the CAN/CSA B149.1 *Natural Gas and Propane Installation Code and STANDATA*.
6. List, define and describe vent connectors and proper installation techniques.
7. Explain regulations pertaining to vent connectors as listed in the CAN/CSA B149.1 *Natural Gas and Propane Installation Code and STANDATA.*

8. Size vent connectors using minimum size rules.

E. Single Line Drawings ..... 4 Hours

Outcome: Draw and interpret basic orthographic and isometric drawings.

1. Identify, draw and label three basic views of orthographic drawings.
2. Identify and draw sections of a simple object.
3. Draw and label orthographic single-line piping drawings with 90° elbows and tees and convert to isometric drawings.
4. Draw and label isometric single-line piping drawings containing 90° elbows and tees.

F. Heating with Alternative Methods ..... 2 Hours

Outcome: Describe alternative heating systems.

1. Describe alternative heat sources.
2. Describe alternative heat source systems.

SECTION THREE: ..... BASIC CONTROLS ..... 32 HOURS

A. Principles of Automatic Heating and Cooling Controls ..... 6 Hours

Outcome: Explain the basic principles for automatic controls for heating and cooling systems.

1. Outline the basic requirements of heating and cooling systems.
2. Describe the control components of a basic forced-air heating system.
3. Interpret basic electrical diagrams used to show the function of a heating or cooling control system.
4. State code requirements relating to the electrical installation of heating and cooling systems.

B. Temperature Sensing and Control Devices ..... 4 Hours

Outcome: Explain the operation of temperature sensing and control devices.

1. Differentiate between the operating characteristics of various temperature-sensing devices.
2. Outline the use and application of various temperature-sensing devices used in heating and cooling systems.
3. Explain how thermostats are used in heating and cooling systems.

C. Basic Gas-Fired Forced-Air Heating Systems ..... 6 Hours

Outcome: Connect and troubleshoot basic 24 V and 120 V gas-fired, forced-air heating systems.

1. Identify the components used in a basic gas-fired, forced-air heating system.
2. Describe the operation of a domestic heating system using a 24 V control circuit.
3. Describe the operation of a unit heater using a 120 V control circuit.
4. Describe the installation and operation of a fan interlock system on a residential forced air heating system.
5. Connect a 24V control heating system and observe its operation.

D. Mid/High-Efficiency / Gas-Fired / Forced-Air Heating Systems ..... 6 Hours

Outcome: Connect and troubleshoot mid and high-efficiency, gas-fired, forced-air heating systems.

1. Identify the components that make up a mid-efficiency, gas-fired, forced-air heating system.
2. Describe the operation of and troubleshoot a mid-efficiency, gas-fired, forced-air heating system.
3. Describe the operation of and troubleshoot a high-efficiency, gas-fired, forced-air heating system.
4. Describe the purpose of and application of auxiliary equipment used with gas-fired, forced-air heating systems.
5. Connect and observe the operation of a direct spark ignition system in a mid-efficiency gas-fired furnace.
6. Connect and observe the operation of a hot surface ignition system in a high-efficiency gas-fired furnace.

E. Basic Hot Water Heating Systems ..... 2 Hours

Outcome: Connect and troubleshoot basic hot water heating systems.

1. Describe the operation of a basic hot water heating system.
2. Identify the purpose and application of the components of a hot water heating system.
3. Analyze and troubleshoot the operation of a hot water heating system.

F. HVAC Rooftop Units ..... 8 Hours

Outcome: Troubleshoot a basic commercial heating and cooling control circuit for an HVAC unit.

1. Describe the components of a typical HVAC unit.
2. Describe the operation of a typical HVAC unit.
3. Differentiate among the applications of thermostats.
4. Describe procedures for troubleshooting a rooftop HVAC unit.
5. Connect and observe the operation of a rooftop HVAC unit.

SECTION FOUR: ..... BASIC ELECTRICAL THEORY ..... 48 HOURS

A. Transformers ..... 4 Hours

Outcome: Explain transformers as used in refrigeration HVAC applications.

1. List the basic features and describe the construction of a single winding transformer.
2. Determine the transformation ratio and volts-per-turn value of a single-phase transformer.
3. Describe basic transformer operation.
4. Describe the operation of current limiting (Class 2) transformers.
5. List the internal losses and calculate the efficiency of a transformer.
6. Describe the connection options for a multiple winding transformer.
7. Identify, connect and perform tests on multi-winding transformers.

B. Single Phase Motors ..... 14 Hours

Outcome: Explain the principles of operation, types and applications of split-phase, single phase motors.

1. Describe the components, principles of operation and applications of a resistance split-phase motor.
2. Describe the components, principles of operation and applications of a capacitor-start motor.
3. Draw typical connection diagrams for single phase motors.
4. Describe the components, principle of operation and applications of a permanent-split-capacitor motor.
5. Describe the components, principle of operation and applications of a two-value capacitor motor.
6. Connect and analyze a dual voltage motor and reverse it.
7. Connect and analyze a multispeed single phase motor.

C. Compressors and Electrical Circuit Components ..... 10 Hours

Outcome: Explain compressors and circuit components.

1. Describe various motor starters and relays of compressors.
2. Describe motor protection used for compressors.
3. Sketch and describe a motor starter circuit.
4. Sketch and describe a typical compressor overload circuit.
5. Connect a single phase compressor circuit.
6. Troubleshoot common motor failures and clean up procedures.
7. Install, wire and check the operation of an oil failure control.

D. Three Phase Fundamentals ..... 6 Hours

Outcome: Explain a three phase electrical system and the differences from single phase systems.

1. Explain the difference between single phase power and three phase power.
2. Explain the generation of the phase voltages of a three phase system.
3. Explain the phase sequence of three phase sine waves.
4. State three main advantages of three phase power over single phase power.

E. Troubleshooting Electrical Problems ..... 8 Hours

Outcome: Solve electrical related problems in refrigeration and HVAC circuits.

1. Describe electrical problems common to refrigeration and HVAC circuits.
2. Describe methods used to test circuits in refrigeration and HVAC circuits.
3. Use wiring diagrams to troubleshoot refrigeration and HVAC circuits.

F. Introduction to Canadian Electrical Code.....4 Hours

Outcome: ***Outcome: Understand why and how the Canadian Electrical Code (CEC) Part I, and the Alberta Electrical STANDATA are used to provide minimum standards for electrical installations in the province. Find information within the CEC Part I, and know who is responsible for electrical installations.***

1. Explain the purpose of the CEC Part 1.
2. Describe the procedures for the acceptance of the CEC by the provinces and the local authorities.
3. Describe the function of the electrical STANDATA.
4. Describe the organizational layout of the CEC.
5. Locate specific information in the CEC using a variety of methods.
6. Identify those responsible for an electrical installation.

G. Class 1 and Class 2 Circuits.....2 Hours

Outcome: ***Identify Class 1 and Class 2 Circuits and describe their CEC requirements.***

1. Define the terms from Section 16 that apply to the second period code program and list the Section 16 topics.
2. Determine the requirements for Class 1 and Class 2 circuits.
3. Identify the Class 2 circuits in a typical single dwelling.

THIRD PERIOD TECHNICAL TRAINING
REFRIGERATION AND AIR CONDITIONING MECHANIC TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS COURSE THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE: .....INTEMEDIATE REFRIGERATION AND AIR CONDITIONING ..... 112 HOURS

A. Refrigeration Load Calculations and Designs.....10 Hours

Outcome: Calculate loads for refrigeration systems.

1. Describe terminology and formulas used in refrigeration load calculations.
2. Describe refrigeration loads.
3. Describe short and long methods of load calculating.
4. Describe infiltration loads and food preservation.
5. Calculate various refrigeration load requirements.

B. System Design and Equipment Selection.....14 Hours

Outcome: Select equipment for refrigeration and HVAC systems.

1. Describe terminology and formulas used in system design and equipment selection.
2. Describe refrigeration and HVAC systems and equipment.
3. Describe equipment applications and limitations.
4. Select various refrigeration and HVAC equipment components.

C. Piping Design and Installation Practices .....36 Hours

Outcome: Design and install refrigeration and HVAC systems.

1. Describe terminology and formulas used in piping design.
2. Describe refrigeration and HVAC piping systems.
3. Describe piping applications and limitations.
4. Describe gas defrosting piping methods.
5. Calculate various refrigeration and HVAC piping systems.
6. Install, connect and analyze a low temperature refrigeration system and components.
7. Analyze the design and installation of a medium temperature refrigeration system and components.
8. Analyze the design and installation of a split HVAC system and components.

D. Defrosting Methods Circuits and Controls .....10 Hours

Outcome: Explain defrosting methods, circuits and controls.

1. Describe terminology and formulas used in defrosting circuits and controls.
2. Describe methods of defrosting.
3. Describe defrosting components and their applications.
4. Install, connect and analyze defrosting components.

E. Troubleshooting of Refrigeration and HVAC Systems.....30 Hours

Outcome: Solve problems in refrigeration and HVAC systems.

1. Describe electrical problems common to refrigeration and HVAC systems.
2. Describe oil problems common to refrigeration and HVAC systems.
3. Describer refrigerant problems common to refrigeration and HVAC systems.
4. Describe compressor problems common to refrigeration and HVAC systems.
5. Describe piping problems common to refrigeration and HVAC systems.
6. Describe air flow problems common to refrigeration and HVAC systems.
7. Describe methods used to test circuits in refrigeration and HVAC systems.
8. Use test equipment to troubleshoot refrigeration and HVAC system problems.

F. Industrial Refrigeration Systems .....8 Hours

Outcome: Explain the design and operation of industrial refrigeration systems.

1. Describe terminology used in industrial refrigeration systems.
2. Describe components of industrial refrigeration systems.
3. Describe applications and limitations of industrial refrigeration components.
4. Describe designs of industrial refrigeration systems.
5. Observe an industrial refrigeration system in operation.

G. Codes Related to Refrigeration and Air Conditioning Installations.....4 Hours

Outcome: Understand how the B52 Mechanical Refrigeration Code and the Canadian Code of Practice are used to provide a minimum standard as it relates to Refrigeration and Air Conditioning installations in the province.

1. Describe how the B52 relates to the refrigeration and air conditioning installations.
2. Describe how the Canadian Code of Practice relates to the refrigeration and air conditioning installations.
3. Demonstrate how the B52 is used in determining minimum standards in a refrigeration and air conditioning install and maintenance work in industrial applications.
4. Demonstrate how the Canadian Code of Practice is used in determining minimum standards in a refrigeration and air conditioning install and maintenance work in industrial applications.

SECTION TWO: ..... INTERMEDIATE HEATING THEORY ..... 32 HOURS

A. Electronic Ignition Systems .....12 Hours

Outcome: Troubleshoot electronic ignitions and components found in HVAC equipment.

1. Describe the operation of basic ignition systems used in mid and high-efficiency furnaces.
2. Describe the application and sequence of operation of electronic controls.
3. Interpret electrical schematic drawings.
4. Describe diagnostic techniques and routine maintenance requirements for electrical controls.

B. Natural and Fan Assisted Draft Appliances.....12 Hours

Outcome: Install and service gas fired appliances, install set-up and ensure safe operation of conversion burners.

1. List and describe requirements the types of burners used in natural and power assisted draft appliances.
2. Describe the operation and function of each type of burner.
3. Explain the relationship between fan speed and volume delivered.
4. Explain the relationship between volume delivered and static pressure.
5. List and explain the selection requirements for a correctly sized fan.
6. List and describe the differences in fan location between natural, induced and forced.
7. List and describe procedures for converting an appliance from one gas to another.
8. List and describe regulations, applicable Gas Codes and Alberta Safety Services Plumbing and Gas Standards.
9. List and explain the safe light-up requirements for various burners.

C. Introduction to Make-Up Air .....8 Hours

Outcome: Explain operation and design of make-up air units.

1. Describe terminology used in make-up air units.
2. Describe components used in make-up air units.
3. Describe applications and limitations of make-up air components.
4. Describe designs of make-up air systems.

SECTION THREE: ..... ELECTRICAL AND PNUEMATIC THEORY ..... 40 HOURS

A. Introduction to Three Phase Motors.....3 Hours

Outcome: Explain the theory of operation of an induction motor.

1. Identify terms related to three-phase induction motor.
2. Describe the characteristics of mechanical loads.
3. Describe the construction of a three-phase induction motor.
4. Describe the principle of operation of a squirrel-cage induction motor.
5. Describe information located on a motor nameplate and calculate horsepower, motor efficiency and speed regulation.

B. Operation of Three Phase Motors.....3 Hours

Outcome: Explain the characteristics of an induction motor rotor as it starts and runs, and as load is applied to the shaft.

1. Calculate rotor parameters including synchronous speed, slip and breakdown torque, and determine the effect that the percent slip has on rotor parameters.
2. Describe NEMA rotor designs A, B, C and D, and their electrical and mechanical characteristics.
3. Describe the wound-rotor motor and its electrical and mechanical characteristics.
4. Describe the relationship between torque and rotor electrical characteristics in a squirrel-cage induction motor.

C. Motor Installations.....14 Hours

Outcome: Install motors in refrigeration and HVAC systems.

1. Describe motor installation methods.
2. Describe three phase motor connections.
3. Describe three phase motor starting methods.
4. Describe methods of reversing three phase motors.
5. Describe three phase motor protection.
6. Connect and analyze a three phase dual voltage motor connection.
7. Connect and analyze a three phase two speed motor connection.
8. Connect and analyze a three phase part winding motor connection.
9. Connect and analyze a three phase wye motor connection.
10. Connect and analyze a three phase delta motor connection.
11. Connect and analyze a three phase star motor connection.

D. Variable Speed Drives.....8 Hours

Outcome: Program, adjust and troubleshoot variable speed drives in refrigeration and HVAC applications.

1. Recall the principles of operation of ac induction motors.
2. Compare methods of speed control of ac induction motors.
3. Describe the principles of operation and application of a typical variable speed drive.
4. Describe the principles of operation and application of a dc motor used with variable speed drives.
5. Connect, program and troubleshoot a VSD.

E. Arc Flash .....2 Hours

Outcome: Demonstrate knowledge of arc flash equipment.

1. Describe arc flash hazards and safety equipment related to arc flash.

F. Diagrams .....6 Hours

Outcome: Interpret electrical diagrams used in refrigeration and HVAC systems.

1. Describe electrical diagrams used in refrigeration and HVAC systems.
2. Describe symbols and terminology used in refrigeration and HVAC systems.
3. Interpret diagrams for refrigeration and HVAC systems.
4. Draw electrical diagrams for a refrigeration and HVAC system.

G. Pneumatic Control Systems.....4 Hours

Outcome: Troubleshoot and repair a basic pneumatic control system.

1. Describe terminology used in pneumatic control systems.
2. Describe components and their applications of a pneumatic control system.
3. Describe methods and tools used to troubleshoot pneumatic control systems.
4. Troubleshoot and repair a basic pneumatic control system.

SECTION FOUR: ..... AIR HANDLING THEORY ..... 56 HOURS

A. HVAC Load Calculations and Design ..... 8 Hours

Outcome: Calculate loads for HVAC systems.

1. Describe terminology and formulas used in HVAC load calculations.
2. Describe HVAC loads.
3. Describe short and long methods of load calculating.
4. Calculate various HVAC load requirements.

B. Advanced Air Properties ..... 6 Hours

Outcome: Explain the properties of air as it relates to advanced air flow design.

1. Describe terminology and formulas used in advanced air flow calculations.
2. Describe the psychrometric chart as it relates to air conditioning systems.
3. Locate and identify the points and lines represented on a psychrometric chart.
4. Describe tools used for measuring air properties.
5. Measure and plot an HVAC system to determine its characteristics.

C. Air Conditioning Systems ..... 32 Hours

Outcome: Explain the principle operations of an air condition system.

1. Describe terms associated with air conditioning systems.
2. Describe the components and their applications of comfort air conditioning systems.
3. Describe the components and their applications of year round air conditioning systems.
4. Describe the components and their applications of process air conditioning systems.
5. Calculate and measure required reading at various points on an air conditioning system.
6. Plot readings from an air conditioning system on a psychrometric chart.
7. Measure and analyze a residential split system.
8. Measure and analyze a commercial air conditioning system.
9. Measure and analyze a heat pump system.
10. Measure and analyze a process air conditioning system.

D. Fans, Belts and Mechanical Drive Systems ..... 4 Hours

Outcome: Explain fans, belts and mechanical systems as they apply to HVAC systems.

1. Describe the components and their applications of fans, belts and mechanical drives in HVAC systems.
2. Describe troubleshooting techniques used for air handling equipment in HVAC systems.
3. Demonstrate troubleshooting techniques for air handling equipment in an HVAC system.

E. Air Instruments and System Balancing ..... 6 Hours

Outcome: Use air instruments to analyze and balance HVAC systems.

1. Define terms used in air balancing.
2. Describe the tools and instruments used in system balancing.
3. Calculate air velocity and volumes using tables and charts.
4. Use air instruments to measure, analyze and balance a HVAC system.

FOURTH PERIOD TECHNICAL TRAINING
REFRIGERATION AND AIR CONDITIONING MECHANIC TRADE
COURSE OUTLINE

UPON SUCCESSFUL COMPLETION OF THIS COURSE THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE: .....ADVANCED REFRIGERATION THEORY ..... 80 HOURS

A. Chillers.....14 Hours

Outcome: Explain the principle operations of chiller system.

1. Define terms used with chiller systems.
2. Describe chiller system components and their applications.
3. Describe an absorption cycle.
4. Describe refrigerants specific to chiller systems.
5. Describe start-up and shut-down procedures of chiller systems.
6. Observe a chiller system in operation.
7. Observe a centrifugal chiller tear-down.

B. Ultra Low Compressions Systems .....10 Hours

Outcome: Maintain ultra low compression systems.

1. Define terms used in ultra low compression systems.
2. Describe the components and their applications of ultra low compression systems.
3. Describe the refrigerants specific to ultra low compression systems.
4. Describe special precautions required in the installation and servicing of ultra low compression systems.
5. Describe troubleshooting techniques used on ultra low compression systems.
6. Operate and analyze an ultra low compression system.

C. Multiplex Systems .....16 Hours

Outcome: Explain multiplex systems.

1. Define terms related to multiplex systems.
2. Describe the components and their applications of multiplex systems.
3. Describe the operation of multiplex systems.
4. Describe troubleshooting techniques used on multiplex systems.
5. Observe and analyze the operation of a multiplex system.

D. Industrial Refrigeration Systems .....20 Hours

Outcome: Explain industrial refrigeration systems.

1. Define terms related to industrial refrigeration systems.
2. Describe the components and their applications of industrial refrigeration systems.

3. Describe the operation of industrial refrigeration systems.
4. Describe troubleshooting techniques used on industrial refrigeration systems.
5. Observe and analyze the operation of an industrial refrigeration system.
6. Overhaul an industrial refrigeration compressor.

E. Circulating Pumps ..... 8 Hours

Outcome: Maintain circulating pumps.

1. Define terms related to circulating pumps.
2. Describe the components and their applications of circulating pumps.
3. Describe the operation of circulating pumps.
4. Describe troubleshooting techniques used on circulating pumps.
5. Calculate performance of a circulating pump using system curve and pump curve.
6. Observe and analyze the operation of a circulating pump.

F. B52 Piping Codes and Canadian Code of Practice ..... 4 Hours

Outcome: Apply the B52 Mechanical Refrigeration Code and the Canadian Code of Practice are used to provide a minimum standard as it relates to Refrigeration and Air Conditioning piping systems in the province.

1. Describe how the B52 relates to the Refrigeration and Air Conditioning piping systems design and construction.
2. Describe how to use the practical hand book for implementing B52 code.
3. Describe how the Canadian Code of Practice relates to the Refrigeration and Air Conditioning piping systems design and construction.

G. Advanced Blueprint Reading ..... 8 Hours

Outcome: Interpret advanced blueprint information.

1. Use basic information found on a blueprint.
2. Interpret basic blueprint.
3. Identify common symbols used in blueprints and legends.
4. Identify abbreviations commonly used in blueprints.
5. Describe the process for developing a material takeoff list.
6. Compile a list of equipment.
7. Compile a list of supply materials.
8. Develop a material takeoff list from a blueprint.

SECTION TWO: ..... ADVANCED HEATING THEORY ..... 48 HOURS

A. Troubleshooting Gas Fired Equipment ..... 8 Hours

Outcome: Operate and maintain gas fired equipment.

1. Describe common problems associated with gas fired equipment.
2. Describe a systematic approach to troubleshooting gas fired equipment.

3. Troubleshoot and solve common problems associated with gas fired equipment.

B. Combustion Analysis ..... 8 Hours

Outcome: Perform combustion analysis.

1. Define terms associated with combustion analysis.
2. Describe tools and equipment used for combustion analysis.
3. Describe procedures used in combustion analysis.
4. Describe safety concerns associated with combustion analysis.
5. Perform combustion analysis.

C. Advanced Make-up Air Systems ..... 16 Hours

Outcome: Explain make-up air systems.

1. Describe auxiliary components of makeup airs systems.
2. Describe advanced control systems of make-up air units.
3. Describe advanced burner operations of make-up air systems.
4. Describe advanced cooling control systems of make-up air units.
5. Observe operation of an advanced make-up air system.

D. Troubleshooting Make-up Air Systems ..... 8 Hours

Outcome: Operate and maintain make-up air systems.

1. Describe common problems associated with make-up air equipment.
2. Describe a systematic approach to troubleshooting make-up air equipment.
3. Commission and start-up a make-up air system.
4. Troubleshoot to solve common problems associated with make-up air equipment.

E. Hot Tapping ..... 4 Hours

Outcome: Explain how to hot tap a gas line to required standard and specifications.

1. Describe the basic safety procedures for the use of hot tap tools including proper valve selection and placement.
2. Describe assembly of the hot tapping tools.
3. Correctly maintain tools and equipment.

F. Workplace Coaching / Mentoring ..... 4 Hours

Outcome: Describe the role of the journeyman tradesmen, employers, the Provincial Apprenticeship Committee and Alberta Apprenticeship and Industry Training in the development and maintenance of the Refrigeration and Air Conditioning Mechanic trade in Alberta.

1. Review the terms of apprenticeship and describe the advancement criteria for an apprentice within the Refrigeration and Air Conditioning Mechanic trade.
2. Explain and describe the purpose of the apprentice record book role for apprentice and employer in competency task check-off requirements and updating procedures.
3. Describe and demonstrate the coaching skills used for training apprentices.

SECTION THREE: .....COMPLEX AIR SYSTEM THEORY ..... 40 HOURS

A. Complex HVAC Systems .....10 Hours

Outcome: Explain the operation of complex HVAC system.

1. Define the terms used in complex HVAC systems.
2. Describe the components and their applications in complex HVAC systems.
3. Describe the methods used to control complex HVAC systems.
4. Describe the designs of complex HVAC systems.
5. Describe the operation of complex HVAC systems.
6. Operate and analyze a complex HVAC system.

B. Troubleshooting Complex HVAC Systems.....12 Hours

Outcome: Maintain complex air conditioning systems.

1. Define common problems associated with complex HVAC equipment.
2. Describe a systematic approach to troubleshooting complex HVAC equipment.
3. Describe maintenance procedures of complex HVAC equipment.
4. Troubleshoot to solve common problems associated with complex HVAC equipment.

C. Advance Mechanical Drives for Fan Systems .....4 Hours

Outcome: Maintain advanced mechanical drives for fan systems.

1. Define terms used for advanced mechanical drives for fan systems.
2. Describe the components and their applications of mechanical drives for fan systems.
3. Describe the properties of fan performance for fan systems.
4. Describe maintenance and adjustment procedures of advanced mechanical drives for fan systems.
5. Troubleshoot complex mechanical drive systems problems.

D. Installation of HVAC Equipment .....8 Hours

Outcome: Install and maintain HVAC equipment.

1. Define installation procedures used in installing HVAC units.
2. Describe considerations of location and equipment when installing HVAC systems.
3. Describe start-up and shut-down procedures of HVAC systems.
4. Describe system maintenance procedures of HVAC systems.
5. Demonstrate start-up and shut-down procedures of various HVAC systems.

E. Energy Conservation and Indoor Air Quality .....4 Hours

Outcome: Explain energy conservation and indoor air quality.

1. Define terms used in energy conservation and indoor air quality.
2. Describe the components and their applications of energy conservation and indoor air quality equipment.

3. Describe designs and principles of energy conservation systems.
4. Describe maintenance procedures of indoor air quality equipment.

F. Advisory Network ..... 2 Hours

Outcome: Explain the advisory network

1. Explain the role and purpose of the advisory network, local apprenticeship committees, and provincial apprenticeship committee.

SECTION FOUR: ..... ADVANCED CONTROL SYTEMS ..... 72 HOURS

A. Specialized Electronic Control Systems ..... 16 Hours

Outcome: Install and maintain specialized electronic control systems.

1. Define the terms used in specialized electronic control systems.
2. Describe the components and their applications of specialized electronic control systems.
3. Describe programming methods of specialized electronic control systems.
4. Describe design and application of specialized electronic control systems.
5. Describe maintenance procedures of specialized electronic control systems.
6. Connect and program a specialized electronic control system.

B. Electromechanical Control Systems ..... 12 Hours

Outcome: Install and maintain electromechanical control systems.

1. Define the terms used in electromechanical control systems.
2. Describe the components and their applications of electromechanical control systems.
3. Describe calibration methods of electromechanical control systems.
4. Describe design and application of electromechanical control systems.
5. Describe maintenance procedures of electromechanical control systems.
6. Connect and calibrate an electromechanical control system.

C. Advanced Electrical Troubleshooting ..... 8 Hours

Outcome: Maintain electrical components found in HVAC and refrigeration equipment.

1. Define problems associated with electrical components in HVAC and refrigeration equipment.
2. Describe a systematic approach to troubleshooting HVAC and refrigeration equipment.
3. Use advanced electrical schematic drawings in troubleshooting electrical problems in HVAC and refrigeration equipment.
4. Troubleshoot to solve problems associated with HVAC and refrigeration equipment.

D. Schematic Diagrams ..... 10 Hours

Outcome: Interpret schematic diagrams used in refrigeration and HVAC systems.

1. Describe types of schematic diagrams used in refrigeration and HVAC systems.
2. Describe symbols and terminology used in refrigeration and HVAC schematic diagrams.
3. Interpret schematic diagrams for refrigeration and HVAC systems.

4. Draw schematic diagrams for a refrigeration and HVAC system.

E. Economizer Controls and Accessories ..... 14 Hours

Outcome: Explain the function and operation of economizer controls and accessories.

1. Define terms used with economizer controls and accessories.
2. Describe the components and their application of economizer controls and accessories.
3. Describe calibration methods of economizer controls and accessories.
4. Describe design and applications of economizer controls and accessories.
5. Connect and calibrate an economizer control system with accessories.

F. New Environmental Technology ..... 8 Hours

Outcome: Explain changing trends in environmental technology related to HVAC and refrigeration.

1. Define terms related to environmental technology as it relates to HVAC and refrigeration industry.
2. Identify issues that may relate to environmental technology as it relates to HVAC and refrigeration industry.
3. Describe the authorities having jurisdiction on environmental technology as it relates to HVAC and refrigeration industry.
4. Identify legislation and codes as it relates to environmental technology for the HVAC and refrigeration industry.

G. Back Flow Prevention (Cross-Connection Control Awareness) ..... 2 Hours

Outcome: Install and service cross-connection control devices.

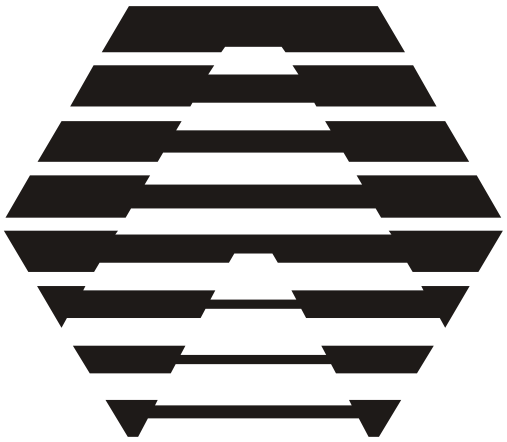
1. Define the terms cross-connection control and state the requirements for tester certification.
2. Briefly discuss the history of cross-connection control in Canada and the program status in Alberta.
3. List and describe definitions that pertain to cross-connection control.
4. Describe the classification of hazards and list typical health issues that may result from cross-connnection.
5. State the liabilities and responsibilities at all levels of a cross-connection control program.
6. List case histories of cross-connections in Canada resulting in inadequate protection.
7. State regulations pertaining to cross-connection control.
8. List and identify the major categories of cross connection control devices and describe their operation.
9. List and describe correct installation procedures for each category of cross-connection devices and list examples of preventing backflow in a potable water supply.
10. Describe the testing procedure for a pressure vacuum breaker.

H. Interprovincial Standards ..... 2 Hours

Outcome: Explain Red Seal / Interprovincial standards

1. Describe the National Occupational Analysis (NOA).
2. Describe the relationship between the NOA and Red Seal / Interprovincial examinations.
3. Discuss the roles of federal and provincial government in the development of Red Seal standards.

4. Discuss the role of industry in the development of Red Seal standards.
5. Explain the intent of the Red Seal exam as it relates to interprovincial mobility
6. Describe sources of information on Red Seal standards and practice examinations.



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